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A NON-PARASITIC MALADY OF THE VINE.

F. E. GLADWIN.

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A NON-PARASITIC MALADY OF THE VINE.

F. E. GLADWIN.

SUMMARY.

1. The trouble under discussion was first observed in a young vineyard during the summer of 1910. Other vineyards growing on the Experiment Grounds have since shown the affection from year to year in varying amounts.

2. The malady at its first appearance was supposed to be chlorosis of the Old World species, but later observations disclosed their dissimilarity.

3. Neither the leaf-blight disease of the vine nor the California vine disease is due to the same causes as the trouble under study.

4. The affection manifests itself on light soils during drouth, or on heavy, impervious soils when excessively wet.

5. Vines affected with the trouble first show a streaked pallidness of the leaves in the intervascular spaces. Later these streaked areas become yellow. The discoloration is more marked near the margins and eventually the pallid areas coalesce and form a yellowed band extending around the margin. As the season advances this band dies and becomes functionless. Isolated areas of the leaf blade deaden and when these join, a considerable part of the leaf tissue may become functionless. When the entire leaf is affected the outer margin often curls upward.

6. The injury is cumulative unless favorable conditions are established in the succeeding years, i. e., optimum rainfall, etc.

7. As a result of the injury to the foliage, growth is materially checked and the wood usually fails to mature well. The fruit does not color nor is the normal amount of sugar fixed. " Shelling " may result.

8. Soils deficient in organic matter and hence in their water-holding capacity are associated with the trouble. Heavy, wet soils likewise contribute to the affection. The sickness is very common to the Volusia Silt Loam type of soil.

9. Young vines with their limited root-range are oftener affected than the older, well established ones, tho the latter may be affected under certain conditions, such as a greatly diminished water supply.

10. Applications of sulphate of iron — the general measure of control for chlorosis in Europe — failed to lessen the affection. Nitrogen, phosphorus, potassium, sodium or calcium did not affect the degree of injury when applied to the soil about sick vines.

11. The incorporation of considerable amounts of organic matter with the soil is a possible corrective. Stable manure and green manures will tend toward this end. Tile drainage is a necessary requisite in many vineyards growing on the heavy soil types, since the interposition of a hardpan, which is fairly common in the Chautauqua and Lake Erie Fruit Belt, limits the vertical root range.

12. Early spring plowing and frequent summer tillage, that result in the maintenance of a dust mulch, conserve moisture during seasons of drouth.

13. Affected vines should be closer pruned than normal ones. The removal of a badly injured vine and its replacement by another plant is rarely successful. When an injured vine of necessity must be removed it can best be replaced by layering a cane from the adjacent vine at one side of the vacated space.

INTRODUCTION.

During the summer of 1910 the attention of the writer was attracted to the sickly appearance of the leaves of several Concord vines growing in a young vineyard three years set, on the grape experiment grounds of this Station at Fredonia, N. Y. In 1911 the trouble again appeared in this vineyard and in others six and seven years planted. In 1912 the affection was noted in all the vineyards previously mentioned, and, in addition, in one twenty years planted and located on a very different soil type from the others. In 1913 the trouble was still apparent in all the vineyards previously noted and in two others planted in 1910. In 1914 the sickly appearance was observed within the limits of the previous years but the twenty-three-year vineyard was practically normal. Since this time the malady has been gradually lessening, isolated areas only remaining in two vineyards that were much affected in 1917. Of the seven years that the trouble has been under observation it was in the most aggravated form in 1912.

IDENTITY OF THE TROUBLE.

At its first appearance the malady was supposed to be chlorosis, a disease common to the Old World species of the vine; but closer observation and a review of the literature pertaining to this disease tend to prove that chlorosis and this trouble affecting the Concord are not due to the same causes. Most writers on the Old World disease state that it is caused or favored by lime in the soil. This can not be true of the trouble under discussion for lime is very deficient in the soils of the Chautauqua and Erie Grape Belt, and especially is this true in the vineyards where these data were taken.

The leaf-blight disease of the vine described by Fairchild,[1] while having some symptoms and environmental factors in common, differs from the one under observation in several material points. He states that leaf-blight is common only to young vines three to four years set. Our observations show that under certain conditions, which will be detailed later, the trouble may be common on much older vines. Again he says, " the worst attacks of this disease occur upon cold, heavy soils containing a large percentage of clay and rich in nitrogenous matter." While it is true that four of the vineyards under discussion are situated upon the heavy soil types, it should also be stated that they are deficient in nitrogen, as has been determined by chemical analysis and from their response to applications of stable manure and commercial nitrogen. The twenty-three-year vineyard, in which the disease was observed in severe form in only one year, is planted on a loose, gravelly loam approximately 20 feet deep. Another is on a light clay to silt loam that is well drained.

In some respects the symptoms manifested by the sick vines are similar to those of the California vine disease of Vinifera varieties, discussed by Pierce,[2] yet the two are so different in other particulars that the troubles can not be produced by the same causes, however alike they may be in some characters. Pierce states that cuttings taken from vines affected with the California vine disease carry with them the disease and thus it is perpetuated. Cuttings taken from vines with the affection under discussion have, after three years' growth, developed as perfectly normal vines without any symptoms of the disease.

[1] Fairchild, D. D. Diseases of the grape in western New York. *Jour. Myc.* 6: 95–98. 1891.

[2] Pierce, N. B. Grape diseases on the Pacific Coast. U. S. Dept. Agr., Farmers' Bul. 30:7–14. 1895.

In the following particulars the malady resembles the "Drouth Spot" disease of apples studied by Mix[3]: Both are favored by a lack of soil moisture. In each abnormal condition of roots is not necessary to bring about the disease. While the leaf characters are quite similar yet they differ in some respects, as for example the disease under discussion seems to affect larger and more well-defined areas than in drouth spots.

However, no die-back of the shoots was observed during the current year but as will be shown later the newly formed canes were injured. Thus far, but one case has been observed upon the so-called better soils, the injury being largely confined to the thin, shallow soils. The grape berries were not affected in appearance except as to size and color at maturity, while in drouth spot the fruit shows diseased areas. Excessive soil moisture is not apparently a contributing factor to the "drouth spot disease", while with the affection under study there is apparently a relationship.

CHARACTERS OF THE DISEASE.

During the dormant season there are no external characters that would indicate that the trouble is present, except perhaps that wood growth is not as well matured, nor the amount grown so great as with the unaffected vines. However, if these conditions are used as criteria in detecting diseased vines, it can be done with certainty only with vines located in similar situations as to soil, elevation and age.

Early in July in average seasons the apical leaves of affected shoots show a streaked yellowing in the intervascular spaces. However, the vineyardist rarely observes this, the beginning stage of the affection. A little later, other leaves on the shoots develop pallidness. The discoloration is more marked near the margin and eventually the pallid areas coalesce and form a yellowed band extending around the margin. As the season advances this band of tissue dries and becomes functionless. The deadened area is further increased by a drying out of the intervascular tissue, extending from the margin inward to the midrib, until in extreme cases the entire tissue of the leaf, except that along the main veins, becomes brown and dead. Often only one side of the leaf shows this extreme stage; in other instances after the marginal tissue has deadened, isolated

[3] A. J. Mix. Cork, drouth spot and related diseases of the apple. N. Y. Agr. Ex. Sta. Bul. 426, 473–522. 1916.

and scattered spots of dead tissue develop without order over the blade. These spots often coalesce so that dead areas of considerable size are produced quite apart from those at the margin. A leaf that has gone thru these successive stages of dying back has only narrow strips of functioning tissue immediately adjacent to the principal veins and veinlets. When the entire leaf area is affected the margin often curls upward.

During the first year an affected vine may be diseased in but few shoots from a single cane, or at most in two or three canes. The year following additional canes usually show the trouble and eventually the whole vine is affected. The disease appears to be cumulative. Vines have been observed that were completely defoliated some time previous to the period of fruit maturity. The fruit of affected vines does not color well, nor is the normal amount of sugar fixed. The berries do not acquire full size, and in extreme cases "shell" from the cluster. When the vine is only moderately affected, "shelling" may not follow, but the fruit is not attractive nor palatable.

Growth is checked materially and the new wood does not mature properly; as a consequence it is unfitted for next year's fruiting, much of it winter-kills, and that not so killed is soft, light in weight and apparently is deficient in stored plant food. The difficulty of obtaining desirable canes for fruiting becomes a serious problem.

OCCURRENCE AND RELATIONSHIP OF AFFECTION TO SOIL.

In 1912, when the trouble was first observed in the twenty-three-year vineyard, much valuable information was obtained, confirming the belief that the sickness is associated with the water content of the soil and the ability of the root systems to absorb it. This vineyard is growing on a very open, gravelly-loam soil approximately 20 feet in depth. In times of severe drouth the vines in it, particularly over the higher parts, are checked in their growth, but if the tillage has resulted in a good dust mulch this has been largely obviated. Since 1909, four plats, of two rows each, have been seeded during late July each year to a green-manure crop of mammoth clover. This crop is plowed under early each spring. In 1912 it was decided to allow the clover in two of the plats, one limed, the other not, to grow during the summer, mow at intervals and leave

the straw as a mulch. The summer of 1912 was very deficient in rainfall. For twenty-seven days previous to July 13, no rain fell. On this date a rainfall of .41 inch occurred. Some days previous to this rainfall the vines in the clover-mulched plats began to show symptoms of sickness which finally developed into the most severe case yet observed. The characters were in every way typical of those vines already cited. In the depression of the rows the injury was not nearly so bad as on the higher locations. The rows immediately bounding the affected plats showed negligible amounts of the trouble, while there was practically none in the other parts of the vineyard. No differences in degree of injury were noted between the limed and unlimed plats, while the vines in the other two clover plats, plowed in the spring and cultivated at frequent intervals, were perfectly normal. In 1913 the vines affected in 1912 showed somewhat the effect of the previous injury, but in 1914 they were normal, healthy vines again. In 1913 and following seasons the clover plats have been annually plowed and given good summer tillage.

Observations made on July 13, 1915, showed the trouble in its first stages within practically the same boundaries in all but the vineyard just alluded to, but apparently fewer vines were affected and these in less degree.

In a vineyard located on a black silt, a complete system of tile drainage had been installed in the fall of 1909. At the time this work was done one or more underground springs were located beneath the black silt areas. As a large number of sick vines had been noted over this soil type several borings were made with the soil auger about the bases of the worst of them. The water table on this date, July 13, was found to be about $2\frac{1}{2}$ feet below the surface. This evidently was much higher than in average years, owing to a total rainfall of 10.27 inches for June and July. Of this total, 8.42 inches fell previous to the date of sampling. The surface soil here consists of five or six inches of black loam, underlaid by a layer of very stiff blue and yellow clay from two to two and a half feet in thickness. Below this clay there is a stratum of coarse sand containing a few small pebbles. The free water was found in this sand layer. A run of tile was opened alongside and within two feet of a vine affected with the trouble. The tile was perfectly clear and carrying a little water. The roots of this vine had not penetrated

PLATE I.— GRAPE LEAVES SHOWING INITIAL AND LATER STAGES OF AFFECTION.

Upper: Pallid areas in intervascular spaces.
Lower: Marginal killing with development of isolated dead areas.

PLATE II.— GRAPE LEAVES SHOWING ADVANCED STAGES OF AFFECTION.

Upper: Marginal killing more advanced than in Plate I.

Lower: Greater part of leaf-tissue functionless; light areas along principal veins still active tissues; leaf ruptured at left of midrib.

PLATE III.— INJURED FOLIAGE ON CONCORD VINE IN SILT SOIL.

Leaves from top shoots dried and much of tissue fallen leaving only petiole and primary veins. Practically all foliage of this vine lost before close of growing period and fruit not harvested.

to more than eight inches, while the greater part of the feeding, fibrous roots were only down from four to six inches. It would appear that here the impervious nature of the sub-soil contributes largely to the sick condition of the vines, thru limiting the wide distribution downward of the active feeding system into the zone of abundant water supply. The clay hardpan interrupts the downward percolation of the rainfall, to the end that there is a rapid runoff of that in excess of the amount that can be taken in as a reserve by the friable but shallow surface soil. The saturation of this limited depth in time of excessive rainfall seriously interferes with the proper aeration of the root system. Likewise the interposed clay hardpan interrupts capillarity from the porous, water-bearing sand, upward to the root zone. In 1916 and 1917 the sickness was again present over this area, but apparently in somewhat diminished form.

Since 1915 the trouble has practically disappeared from the young vineyard mentioned as on a knoll made up of yellow silt. It was believed during the first years of this study that the only remedy here was the removal of the greater number of the sick vines and their replacement by others from the nursery; however, no vine has been removed from the vineyard by reason of the affection. It is probable that the vines here will in time acquire a root system extensive enough to supply the moisture losses thru evaporation and transpiration. The water storage capacity of this soil has been greatly increased by the turning under each season of green manures. Our observations indicate that newly planted vines in soils deficient in organic matter usually show the sickness under discussion for the first few years after planting, but tend to overcome the trouble as they become older and in closer contact with the soil. In 1917 there was no indication that these vines had been other than normal at any stage of their development.

FACTORS THAT CONTRIBUTE TO THE AFFECTION.

Considering the facts at hand it would seem that a lack of available soil moisture, at critical periods in the vine's growth, or a lack of root aeration as a result of the impervious sub-soil together with the shallow depth of surface soil, are the principal contributing factors to the affection. With this soil type the sickness is at its height in seasons of drouth as well as in those of excessive rainfall.

Soils such as the yellow silt are generally deficient in organic matter, and hence in their water-holding capacity. With them the affection is worst in seasons of drouth and least in those of normal rainfall. During early summer the vine makes a rapid growth of succulent shoots and leaves which require large amounts of water to develop. The loss thru transpiration as well as from soil evaporation is greatly favored in the Chautauqua-Lake Erie Fruit Belt by the dry prevailing winds from the south and southwest. In the case of the vines growing under the clover-mulch system in 1912, the injury was probably influenced by the added moisture requirements of the growing clover roots, together with a mulch insufficient to check soil evaporation as thoroly as the usual dust mulch. It should be stated here that the result with a mulch in this instance is not indicative of the value of the practice, as the amount of straw obtained from the two cuttings did not suffice even to furnish a thin covering over the soil area. Had the season been one of normal to above normal rainfall it is believed that no such ill effects would have occurred with these vines. The fact that the injury was considerably less in a depression where soil moisture was more abundant tends to this belief.

Reports from vineyardists and many observations in vineyards away from the Station lead to the conclusion that the trouble is wider spread than our earlier observations indicate. As new plantings, under soil conditions here outlined, come to bearing, the affection is liable to be more prevalent, since the soils more fitted for vineyard planting are largely so utilized, leaving available only the light, thin soils or the poorly drained clays. Invariably the trouble from the various localities is reported under the same situations and conditions as outlined herein. The reports also agree in that it is usually the newly planted vineyard that is affected.

CONTROL MEASURES.

That the trouble is connected in some way with the root system in its relation to the soil was evident early in the observations. The first affected vines extended diagonally across a knoll composed in large part of a light yellow silt, and in each row the knoll practically limited the extent of diseased vines.

As the appearance of the injured foliage indicated a possible relationship with chlorosis of Vinifera varieties growing in France,

the accepted remedial measures for its control in that country were tried out in the Station vineyard with a number of badly affected vines located on the above soil type. Other nearby vines were reserved as checks. Sulphate of iron was applied to the soil about the bases and in water as a spray for the aerial parts. This material was used for three seasons and at varied strengths. The behavior of the foliage and fruit was noted carefully at frequent intervals during the period, but in no case were the treated vines better in foliage and fruit than the check vines.

Both the soil and subsoil of the knoll were compared as to physical composition with that from other parts of the same vineyard where the vines were unaffected. The soil over the knoll proved to be of a much finer texture with but few coarse particles, and apparently very deficient in organic matter. By reason of its elevation and lack of organic matter it is low in moisture content, except during wet seasons. Soils from the vicinity of normal vines was found to be of a much darker color, heavier and with much more coarse material. Chemical[4] analysis of the two varied types revealed no striking differences in nitrogen, phosphorus, potassium or calcium carbonate content. In two other affected vineyards the sub-soil is very similar to that whereon are found the badly diseased vines just cited.

Tests over a period of three years with the principal elements of fertility, nitrogen in nitrate of soda and dried blood, potassium in sulphate and muriate of potash, calcium oxid or calcium carbonate have not affected the degree of injury from the malady. As in the tests with sulphate of iron, vines noted in previous years as badly affected were marked, and the above elements applied, while others showing approximately the same extent of injury were left untreated. In these tests, as with the sulphate of iron, the control was judged from the appearance of the foliage and fruit on the treated and untreated vines. In either case the worst affected vines lost the larger percentage of their leaves some time before the ripening period, and as a result the fruit did not color nor acquire character. Much of the fruit "shelled" and thus was not harvested, that remaining being unfit even for the poorer wines.

[4] Analyses made by the Agronomy Department at Geneva.

HOW MAY THE ILL EFFECTS BE LESSENED?

Since the trouble now appears to be associated with the supply of soil moisture at critical periods, practices that result in the incorporation of considerable amounts of organic matter with the soil suggested themselves as possible correctives. Consequently it has been the aim at the experiment grounds to apply this principle as well as the several suggestions that follow. Observations have been made at the Station as to the effects of underdrainage upon the malady, while the manner of pruning as later advised is based upon practice in our vineyards.

The addition of organic matter may be accomplished by the use of relatively large amounts of strawy stable manure, turning down green manure crops annually and the utilization of straw, grasses and weeds from waste lands. It is possible, of course, to interrupt soil capillarity thru the use of excessive amounts of coarse materials, hence it is suggested that, when coarse materials are to be used, they be composted and later applied in a partially decomposed state.

With soils that do not allow of sufficient root development by reason of wetness, thoro tile drainage is of first consideration. That the vines may profit most from tiling, it should be done a few years previous to planting.

Soils that consist of a shallow, friable surface layer underlain by stiff, almost impervious clays should in addition to tiling be deeply sub-soiled before planting. Soils that will not admit of sub-soiling by reason of closely underlying rock layers should be entirely avoided for vineyard purposes. Where, for financial reasons, tiling is not to be done, more planting space should be given between the rows and the vines set at a greater distance in the row. This insures a wider lateral root range. The tendency for the past few years has been to closer planting on this soil type, with ill effects.

The importance of early spring plowing, followed by an immediate cultivation or discing, and tillage after each heavy rainfall has demonstrated its value. If the soil be one that can only be worked under the most favored conditions in the spring, it should be fall-plowed. We have found that the vineyard plowed in the fall can be disced or harrowed much earlier and easier in the spring than if the plowing is done in the spring.

Vines affected with the trouble should be more closely pruned than normal vines. In severe cases that have extended over some years with no apparent improvement, the vines should be cut back to the ground. It avails nothing to take out such vines and plant others in their places, as is ordinarily done, for the causes are in the soil and not in the vine. A vine reset in a soil that has favored the trouble is under greater adverse conditions for growth than the one removed and already partially established, as the competition of the vine roots for moisture and plant food is very keen, and the older vine with a partially established root system is in a position to get hold of these much more readily than the newly planted one, whose roots are not as yet in close relation to the soil.

If an affected vine fails to respond to the practices above outlined and its removal becomes necessary, it is far better to replace it by layering a cane from an adjacent healthy vine in the space vacated. In order that the cane thus utilized be held firmly in place and in contact with the soil while roots from it are striking, two small stakes or pegs are driven crossed, so that they hold the cane between them at the point where it is desired the vine shall root. From this point the cane is carried in an upright position above the ground level, where it is cut off so that two or three buds will project above the soil when the trench or hole is filled. By keeping the cane attached to the parent plant for two or three years, plant food elaborated by the older vine will be passed on to the layer while its roots are forming, and then when it is sufficiently well established the cane can be severed from the parent with no interruption in the growth processes. A layer thus made will live under adverse climatic and soil conditions fatal to a nursery vine. The practise of layering makes necessary the selection of desirable canes that are located at the extremities of the arms adjacent to the vacant positions. There should not be much difficulty on this score for, with the Chautauqua system of training, the better canes are in just these positions. Often the arm that is to carry the layering cane is selected two years preceding the actual layering.

The presence of many vines affected with the trouble appears at first hand to foreshadow the early end of a commercial vineyard, yet our observations on the Station grounds and elsewhere indicate that there is a gradual recovery under average vineyard care, while it is much more rapid as the various unfavorable influences are

corrected. As already stated, it is futile to pull out a vineyard seriously affected with the trouble, and reset within a year or two with the expectation of good results. The soil should have returned to it several crops of green-manures before the vines are again located. It is quite possible to grow annual crops successfully on the soils favoring the affection in the event of removal of vines by reason of it.